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Photoautotrophic organisms control microbial abundance and diversity in biological soil crusts

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Vascular vegetation is typically quite sparse or even absent in dryland ecosystems all over the world, but the ground surface is not bare and largely covered by biological soil crusts (referred to as biocrusts hereafter). These biocrust communities generally comprise poikilohydric organisms. They are usually dominated by photoautotrophic cyanobacteria, lichens and mosses, growing together with heterotrophic fungi, bacteria and archaea in varying composition. Cyanobacteria-, lichen- and moss-dominated biocrusts are known to stabilize the soil and to influence the water budgets and plant establishment. The autotrophic organisms take up atmospheric CO_2, and (cyano-)bacteria fix atmospheric nitrogen. The intention of the present project was to study the relevance of the dominating photoautotrophic organisms for biocrust microbial composition and physiology. High-throughput sequencing revealed that soil microbiota of biocrusts largely differ from the bacterial community in bare soil. We observed that bacterial and fungal abundance (16S and 18S rRNA gene copy numbers) as well as alpha diversity was lowest in bare soil, and increasing from cyanobacteria-, and chlorolichen- to moss-dominated biocrusts. CO_2 gas exchange measurements revealed large respiration rates of the soil in moss-dominated biocrusts, which was not observed for cyanobacteria- and chlorolichen-dominated biocrusts. Thus, soil respiration of moss-dominated biocrusts is mainly due to the activity of the microbial communities, whereas the microorganisms in the other biocrust types are either dormant or feature functionally different microbial communities. Our results indicate that biocrust type determines the pattern of microbial communities in the underlying soil layer.